

THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
MASTER OF TECHNOLOGY IN INDUSTRIAL ENGINEERING – LEVEL 07
FINAL EXAMINATION – 2010/2011
MEX 7125 – ENERGY MANAGEMENT IN INDUSTRIES
DATE : 31 March 2011
TIME : 1400-1700 hrs
DURATION : Three (03) hours



Instructions

1. Read the questions carefully before answering.
 2. Please note that you should write your registration number and your index number in each pages of your answer book. Do not write your name.
 3. In case of doubt, please consult the supervisor or an invigilator conducting the examination.
 4. **Answer only five (05) questions including question Q1 as it is compulsory.**
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Q1.
CASE STUDY

Recently, a team of energy auditors conducted an energy audit in a Tourist Holiday Resort near sea where there are 25 individual Guest Rooms with all facilities and are spread over an approximately one acre of land area. One of the audit focuses was the Air Conditioning of the Guest Rooms. The audit revealed that all Guest Rooms had been air conditioned individually using split type air conditioners. Of the 25 rooms, 20 rooms had 12,000 Btu/h split AC units and 05 rooms had 18,000 Btu/h units. Auditors monitored the performance of 40% randomly selected sample from all Guest Room ACs and took necessary measurements to find out the Energy Efficiency Ratio (EER) of the ACs. The EERs of the random sample thus estimated are given in the Table 1 below. The calculated EERs were based on the actual refrigeration effect of the individual ACs (not the installed capacity) and their respective energy consumptions, to estimate these auditors took the necessary measurements during the audit. Measurements taken for estimating the refrigeration effect are not given in the Table 1. The auditors compared these EERs with that of BEST AVAILABLE TECHNOLOGY (BAT) EER of 13 Btu/h.Watt, and thought that there was some opportunity for improving energy efficiency of Guest Room ACs.

In addition, on investigation of the usage pattern of the air conditioners, the auditors found that the tourists spent nearly 09 hours per day outside the room. That means about 07 hours (03 hours in the morning and 04 hours in the afternoon) they spent time in the beach or in the sea, and nearly 02 hours for meals. This approximate daily routine of tourists was confirmed by the hotel General Manager (GM) as well. Here also, the auditors thought that, there was an opportunity to conserve energy consumption of air conditioners in the Guest Rooms. On discussion with management, it was revealed that ACs in guest rooms are on all 24 hours a

day and all rooms are fully occupied 300 days per year. When auditors discuss with the housekeeper in-charge of the guest rooms, it was revealed that tourists invariably locked the room door and take the key with them whenever they leave the room and do not have the habit of switching off the ACs. When inquired about this from GM, he informed the auditors that the ACs in the Guest Rooms can be switched off when they are not occupying the rooms, but he said that he would like to know how this could be done in a convenient manner, for times of guests leaving and returning to the rooms vary widely.

The auditors found that all thermostats of the room ACs were working well, and could be assumed that ACs are loaded for at least 80% of the time (That means although ACs are switched on all the time they actually works only 80% of the time and 20% of the time they are automatically switched off by the thermostatic control).

Table 1 – Details of Sample ACs Monitored and Measurements Taken

Room No	Installed Capacity – Btu/h	Measurements	
		Power Consumption – kW	EER – Btu/hr. Watt
2	12,000	1.200	8
5	12,000	1.250	7
7	12,000	1.150	7
8	12,000	1.400	7
13	12,000	1.100	9
14	12,000	1.220	8
17	12,000	1.300	7
19	12,000	1.230	10
21	18,000	1.900	9
25	18,000	1.850	10

Answer the following questions

1. Define Energy Efficiency Ratio (EER) as applicable to room air conditioners
2. Calculate approximate present annual energy consumption by all Guest Room ACs.
3. Give four practical reasons for causing energy inefficiency in Split type air conditioners.
4. Given the BAT EER of 13 Btu/h. Watt, calculate the energy saving potential by improving the EER of present ACs.
5. What technological solutions you suggest to switched off and switch on the ACs in the Guest Rooms when guests leave the room and occupy the room respectively.
6. Calculate the energy saving potential by implementing the solution you suggested in 4 above.

You may make any reasonable assumptions, if necessary, for facilitating your answer, but shall be very clearly indicated.

(36 marks)

Q2.

Write short notes on four (04) of the following.

- a. "Demand Side Management" as applied to electrical energy.
- b. "Power Factor" in electricity usage.
- c. "Latent Heat Load" in air conditioning.
- d. "Effect of Moisture" in determining the calorific value of fuel wood.
- e. "Specific Energy Consumption" as applied to an industrial process.

(16 marks)

Q3.

- a. In industrial electricity tariff the component of Maximum Demand Charge is often called the "Penalty Charge". Explain why?
- b. Discuss in detail the options available for industrialists to minimize the Maximum Demand Charge.

(16 marks)

Q4.

- a. "Energy Efficiency improvement is a continuous activity". Discuss this statement.
- b. What are the basic components of an Energy Management System (EMS)? Explain how you would organise an EMS in an industrial environment and put it into practice.

(16 marks)

Q5.

- a. With regard to Global Warming, Carbon Dioxide (CO₂) is considered the most significant Green House Gas (GHG) due to anthropogenic (caused by human activities) sources. Discuss these anthropogenic sources that are responsible for CO₂ emissions.
- b. What are the options that have been already adopted and that are being considered worldwide for mitigating the anthropogenic CO₂?

(16 marks)

Q6.

- a. With the recent introduction of Net Metering in Sri Lanka, industrialists are given the green light to harness Renewable Energy. The deal entails several advantages both to the government and the industry. Discuss in details the advantages that are accrued to the government, as well as to the industrialists by harnessing renewable energy and going for Net Metering.
- b. 'Energy Labelling' is one of the Demand Side Management initiatives undertaken by the government. Discuss in detail how consumers could be benefited by this initiative.

(16 marks)

END